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DIGESTIBILITY OF INGREDIENTS IN TWO PELLETED DIETS BY *Macrobrachium rosenbergii* (de Man)

KENNETH CHIN SUI SIAN

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KENNETH CHIN SUI SIAN

MASTER OF SCIENCE

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UNIVERSITI PERTANIAN MALAYSIA

DIGESTIBILITY OF INGREDIENTS IN TWO PELLETED DIETS BY *Macrobrachium rosenbergii* (de Man)

by

Kenneth Chin Sui Sian

A thesis submitted in partial fulfilment of the degree of Master of Science in the Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia

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It is hereby certified that we have read this thesis entitled 'Digestibility of Ingredients in Two Pelleted Diets by Macrobrachium rosenbergii (de Man)' by Kenneth Chin Sui Sian, and in our opinion it is satisfactory in terms of scope, quality, and presentation as partial fulfilment of the requirements for the degree of Master of Science

.....

SULAIMAN M. YASSIN, Ph.D.
Professor/Dean of Graduate Studies
Universiti Pertanian Malaysia
(Chairman Board of Examiners)

.....

CHO, C. YOUNG, Ph.D.
Department of Nutritional Science
University of Guelph
Guelph, Ontario, CANADA
(External Examiner)

.....

MOHD. SALLEH KAMARUDIN, M.S.
Department of Fisheries Biology and Aquaculture
Universiti Pertanian Malaysia
(Internal Examiner)

.....

LAW AH THEEM, Ph.D.
Associate Professor
Department of Fishing Technology and
Marine Science
Universiti Pertanian Malaysia
(Internal Examiner/Supervisor)

This thesis was submitted to the Senate of Universiti Pertanian Malaysia and was accepted as partial fulfilment of the requirements for the Degree of Master of Science.

Date: 21 JUL 1988

.....
SULAIMAN M. YASSIN, Ph.D.
Professor and
Dean of Graduate Studies

DEDICATION

To my wife Theresa and our families through whom God has blessed me.

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by

Kenneth Chin Sui Sian

1988

Chief Supervisor : Law Ah Theem, Ph.D.

Co-Supervisors : Ang Kok Jee, Ph. D.

Mohd Salleh Kamaruddin, M.S.

Faculty : Fisheries And Marine Science

The digestion coefficients of nutrients in two diets containing 30% and 40% protein were evaluated in the Malaysian giant freshwater prawn *Macrobrachium rosenbergii*. Chromic oxide was used as an internal marker for the evaluation of digestibility. Evaluations were carried out with juvenile and adult prawns including female prawns undergoing three different stages of gonad maturation.

The results indicate that the adult prawns were able to digest the nutrients of the ingredients better than the juveniles. In the two diets tested copra cake, wheat flour and soyabean meal were better digested than fish meal and shrimp meal for both juvenile and adult prawns. Copra cake was found to be a good source of lipids (71-100%), carbohydrate (85-96%) and dry matter (72-92%) as well as a good attractant. Carbohydrate, gross energy and dry matter were very well digested in wheat flour with values of 93-100%, 86-95% and 85-97% respectively. Soyabean meal gave good digestion coefficients for protein (84-99%), lipid (90-97%) and carbohydrate (80-100%). The results indicated that copra cake, wheat flour and soyabean meal are good sources of nutrients for *M. rosenbergii*. No differences in digestibility was observed for the female prawns with green, yellow and orange gonads. This showed that the stage of gonad maturation has no significant effect on digestibility.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian dari keperluan untuk Ijazah Master Sains.

KEBOLEHCERNAAN BAHAN-BAHAN DALAM DUA MAKANAN BERUNTIL OLEH Macrobrachium rosenbergii (de Man).

Oleh

Kenneth Chin Sui Sian

1988

Ketua Penyelia : Law Ah Theem, Ph.D.

Penyelia bersama : Ang Kok Jee, Ph. D.
Mohd Salleh Kamaruddin, M.Sc.

Fakulti : Perikanan Dan Sains Samudra

Kebolehcernaan nutrien dalam dua makanan yang mengandungi 30% dan 40% protein telah dikaji dalam udang Macrobrachium rosenbergii. Kromik oksida telah digunakan sebagai bahan penanda. Kajian ini telah menggunakan udang juvenil, dan udang dewasa serta udang betina yang berada dalam tiga tahap kematangan gonad yang berlainan.

Keputusan kajian ini menunjukkan bahawa udang dewasa lebih cekap menghadam nutrien bahan-bahan makanan daripada udang juvenil. Dari kedua-dua makanan beruntil yang dikaji didapati bahawa kelapa, gandum dan kacang soya lebih cekap dicerna dari serbuk udang atau serbuk ikan. Kelapa merupakan sumber yang baik untuk lemak (71-100%), karbohidrat (85-96%) dan bahan kering (72-92%). Ia juga merupakan bahan penarik yang baik untuk udang ini. Karbohidrat, tenaga kasar dan bahan kering dicerna dengan cekap dalam gandum dan nilai-nilainya adalah 93-100%, 86-95% dan 85-97%. Kacang soya telah memberi nilai-nilai yang tinggi bagi protein (84-99%), lemak (90-97%) dan karbohidrat (80-100%). Maklumat-maklumat ini menunjukkan bahawa kelapa, gandum dan kacang soya adalah sumber-sumber nutrien yang baik bagi M. rosenbergii. Bagi udang betina yang mempunyai gonad yang berwarna hijau, kuning dan oren tiada perbezaan dalam kebolehcernaan didapati. Ini bermakna tahap kematangan gonad tidak ada kesan terhadap kebolehcernaan.

CHAPTER 1

INTRODUCTION

The Malaysian giant freshwater prawn, *Macrobrachium rosenbergii*, is a high priçed delicacy in Malaysia. It remains as an important candidate for freshwater aquaculture since there is a downtrend in its supply from capture fisheries due to decreasing wild stocks (Rabanal, 1982; Ong and Pang, 1982).

The culture of the giant freshwater prawn has been shown to be economically profitable in Taiwan (Liao and Chao, 1982), and in Malaysia (Tiensongrusme, 1983). In Malaysia prawn farming is fast expanding especially with regards to the marine prawn *Penaeus monodon.* However the mass production of the giant freshwater prawn has been hindered by some serious problems such as unreliable fry supply, poor management, and a lack of cost effective feeds. Although in Malaysia advances have been made in the mass production of *M. rosenbergii* postlarvae (Ang and Cheah, 1983), the development of a commercial feed for this species of prawn still lags behind.

In the natural environment, M. rosenbergii juveniles and adults have been reported to be omnivorous. Their diet consists mainly of various plants and animal material including detritus, grass roots, insect larvae, seeds, flesh and offal of fish (Ling and Merican, 1961; Ling, 1962; Fujimura, 1972). Prawns are deliberate feeders consuming large quantities of food and engage in frequent feeding activity due to its relatively short digestive tract. Food is located mainly by touch and smell with the use of the antennae and antennules. Prawns masticate their food ingesting small particles whole.

Traditional prawn culture in Malaysia has long relied on the natural productivity of the pond and to a lesser extent on supplemental feeds such as unprocessed agricultural wastes (copra cake, rice bran), grains, trash fish and commercial poultry pellets. However, the use of such materials have limitations especially due to handling and storage problems as well as the imbalance of nutrients. In any semi-intensive and intensive prawn culture system a nutritionally balanced diet has to be supplied in order for the prawn to grow at an optimal rate. It has been shown that substantial increase in the growth of juvenile M. rosenbergii can be obtained using formula feeds (Stahl, 1979, Fair and Fortner, 1981). Feed, however, accounts for a large portion of the total operational costs of a prawn farm. In South Carolina it was 42% of total costs (Roberts

and Bauer, 1978) and in Taiwan it was at least 30% of total costs (Liao and Chao, 1982). The costs of prawn feed varies considerably in South East Asia and in general it is expensive. In Malaysia, the price range is between 0.88 - 1.40 US$/kg (Akiyama, 1987). The high cost of this feed is due to several reasons. The inadequate knowledge of prawn nutrition and high cost of feed ingredients are some of the reasons. There is also minimal or no use of least-cost programs in prawn feed formulations. This is due to the inability of the feed manufacturer to replace a feed ingredient with another to obtain the same feed quality. The ingredients used in the present feed are also very expensive because most of these are imported. There is a lack of information on the utilization of locally produced, non-conventional feed ingredients such as copra meal, rice bran and palm oil kernel. Since feed costs constitute a high proportion of the operating expenditure in prawn culture, feeds offer more opportunities for reducing production costs through their refinement. The development of an economically and nutritionally efficient prawn feed will not only cut costs but also improve production. Prawn feeds have been generally evaluated in terms of growth with less attention given to the digestibility of compounded diets or the individual feedstufs by prawns. Digestibility data provide important nutritional information concerning feeds or feedstuffs that supplement growth measurements.

Current Status of Prawn Nutrition Research in Malaysia

The initial observations on the feeding habits of Macrobrachium rosenbergii was reported by Ling (1962). Poh (1985) simulated the amino acid profile of M. rosenbergii in test diets composed of fish meal, shrimp meal, soyabean meal, copra cake, and wheat flour. Linear programming was used to formulate diets with 25%, 30%, 40% and 50% protein levels. Growth trials experiments by Poh (1985) with postlarval and juvenile M. rosenbergii showed that the 40% diet gave the best growth whereas the 30% diet produced the best feed conversion ratio. From these results Poh recommended that the optimum protein level for young M. rosenbergii is 40%. Recent pond trials of M. rosenbergii under semi-intensive systems (Ang, 1987) at Universiti Pertanian Malaysia using Poh's formulation of 30% diet yielded an average of 873.2 kg/ha/158 days cycle and a FCR of 1.43 and 2.08.

Yong (1986) studied the effect of split rations on nursery production of M. rosenbergii. She reported that feeding 3 times a day resulted in a better survival than feeding once or twice a day.

Ang et. al. (1987) studied the effect of the binder, Basfin, on the growth of M. rosenbergii. They found that the optimum level of Basfin was 0.5%.

Cheah et al. (1987) studied the response of M. rosenbergii larvae development when fed a 40% protein diet (Poh, 1985), egg custard, cockles and M. lanchesterii flesh. They found that the larvae grew the best when fed with the 40% protein diet and Artemia.

Besides these studies, no systematic approach has been adopted to examine the prawns nutritional requirements with regard to locally available feedstuffs.

Although Poh's formulation produced the desired growth, the role of each component of the diet in terms of digestibility by the prawn was not understood. It has been shown that the absorption of nutrients by an organism will vary with the nutrient source. It is therefore necessary to obtain more information concerning the diet recommended by Poh particularly in terms of the digestion coefficients of the nutrients in each of the ingredients used. Hence this study was conducted to solve some of the problems.

The main objective of this study is to obtain the apparent digestibility and digestion coefficient values for dry matter and the nutrients in the 30% and 40% protein diets, and the ingredients used in the diets. It is hoped that the results of this study will enable the formulation of a feed which is cost-effective and which will promote better growth of the prawn.

LITERATURE REVIEW

Techniques Used In Digestibility Studies in Fish Nutrition

The development of an adequate feed in terms of nutritional content and digestibility is essential for the large scale production of M. rosenbergii. Not only must the diet contain ingredients of the proper nutritional quality and quantity, the nutrients of the ingredients must be easily absorbed. A feedstuff may appear from its chemical composition to be an excellent source of nutrients but will be of little actual value unless it can be digested and absorbed by the prawn. Lovell (1977) indicated that nutrient digestibility among feedstuffs varied considerably for different warmwater fishes. The same observation has been noted for prawns. For example, wheat starch was better digested than potato starch in the prawn, Palaemon serratus (Forster and Gabbott, 1971). Akiyama (1986) found that Penaeus vannamei digested soyabean proteins better than fish or shrimp proteins. In order to minimize food wastage, each dietary ingredient should be evaluated on the basis of digestibility. The information collected for various ingredients will provide a useful source of information concerning the types of ingredient suitable for use as prawn feeds. Knowledge of nutrient availability of the components of prawn feeds is desirable so that effective substitutions of one component for another may be achieved. Such

substitution can be important in the development of least-cost diets. However, the lack of knowledge of the nutrient availability of the different feedstuffs used in prawn feeds limits the attempts at ingredient substitution.

Digestibility is defined as the percentage of ingested nutrients which are not rejected as feces (Schneider and Flatt, 1975). The determination of digestibility involves measuring the amount of a specific nutrient or feedstuff ingested and subtracting that which is present in the feces following digestion. Endogenous material such as secretions from within the intestinal tract, sloughed epithelial cells, and other material of metabolic origin may also occur in the feces. Since most studies fail to consider such endogenous materials, apparent rather than true digestibility is reflected.

Digestibility can be measured using one of three different techniques. These are the total collection for gravimetric measurement, the use of indigestible tracers and the use of radioisotopic markers.

Gravimetric measurement of digestibility involves the measurement by weight of total food intake and total fecal production. A known amount of feed is given to the prawn and the egested material is collected and weighed. The difference between the amount consumed and that recovered is

the amount assimilated. The problem with this technique is the difficulty in measuring the total amount of ingestion and defecation accurately.

Various compounds have been utilized as indigestible tracers in the determination of digestibility. These include chromic oxide, long chain fatty acids, metallic iron powder, radioisotopic markers, non-hydrolyzable organic or inorganic constituents and total ash. The two markers most commonly used for aquatic animals are chromic oxide and total ash. By mixing an indigestible marker into the feed or by measuring an endogenous marker, digesti-bility can be calculated by comparing the ratio of the marker in the feed and the feces.

Conover (1966) introduced an ash-ratio technique for the determination of absorption efficiency in aquatic animals. This technique assumed that only the organic components of a feed is significantly absorbed during the digestion process. The ash is then considered as an indigestible marker in a diet and percent digestibility could be calculated by comparing the ash content of food and feces. Although this technique has been applied to a wide range of crustaceans including M. rosenbergii (Clifford and Brick, 1979), the assumption that the ash component of a ration is not absorbed may not hold true in all cases.